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Federal Lake Erie Water Quality Standards Proposals

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FEDERAL LAKE ERIE
WATER QUALITY STANDARDS
PROPOSALS

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

JUNE 1972

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I. INTRODUCTION

Section 10 of the Federal Water Pollution Control Act allows each State, after public hearings, to adopt water quality criteria and an implementation and enforcement plan for interstate waters within its borders. If the State proposed criteria and plan are approved by the Administrator of the Environmental Protection Agency, or his duly authorized designate, as being consistent with the objectives of the Section, such criteria and plan thereafter become the water quality standards applicable to such waters. Acting pursuant to provisions of Section 10, all States contiguous to Lake Erie have established water quality standards for the Lake. These standards have been Federally approved in the following fashion.

State	Fully Approved	Partially Approved
Michigan		X[1]
Ohio		X[2]
Pennsylvania	X	
New York	X	

[1] *Exceptions for temperature - all interstate waters.*

[2] *Exceptions for temperature and dissolved oxygen, Aquatic Life A waters. No Mahoning River standards approved.*

State standards were Federally approved with the qualification that as knowledge and comprehension of the factors affecting water quality increase, and as waste treatment and control technology improves, established State-Federal standards would be reviewed and as necessary, modified, expanded and upgraded for the better protection and enhancement of the waters to which these standards apply. In view of (a) the critical water quality problems presently existing in Lake Erie, (b) the lack of consistency related to existing State-Federal Lake Erie standards, and (c) the recently signed agreement between the United States and Canada protecting Great Lakes water quality, review and revision of the established standards is particularly appropriate at this time. Accordingly, the United States Environmental Protection Agency (USEPA) has developed water quality criteria designed to better protect and enhance the quality of Lake Erie waters and to fulfill the recently defined international obligations. This proposal enunciates these recommended criteria, together with the underlying rationale. The materials have been prepared for the consideration and action of the States contiguous to the Lake.

II. PROPOSED LAKE ERIE WATER QUALITY CRITERIA

A. CRITERIA APPLICATION & WATER USE DESIGNATION

Lake Erie shall be capable of supporting all uses and the criteria contained herein shall apply at all times to all portions of the Lake except for defined, limited areas of mixing and other designated areas where natural conditions result in water quality inconsistent with the crit_ria established herein.

B. ANALYTICAL METHODOLOGY

All chemical analyses shall be performed employing procedures described in Methods for Chemical Analysis of Water and Wastes, EPA, 1971 or the most recent subsequent edition of that volume. Non-chemical analyses shall be performed employing procedures described in Standard Methods for the Analysis of Waters and Wastewaters, 13th Edition, or the most recent subsequent edition of that volume.

C. SAMPLING METHODOLOGY

Samples shall be taken in the surface three feet (one meter) except that where required to determine the true distribution of pertinent contaminants, measurements shall be made at greater depths and at several depths as a chemical profile.

D. NON-DEGRADATION

Waters whose existing quality is better than the established standards at the date of their adoption will be maintained in their present high quality. Such waters will not be lowered in quality unless and until it is affirmatively demonstrated that such change will not interfere with or become injurious to any appropriate beneficial uses made of or presently possible in such waters and that such change is justifiable as a result of necessary economic or social development. In implementing the policy of this paragraph, the Administrator of Region V, USEPA, shall be kept advised and provided with such information he will need to discharge his responsibilities under the Federal Water Pollution Control Act, as amended.

E. MIXING ZONES (GENERAL)

Design and location of mixing zones shall comply with the following regulations:

1. Two or more mixing zones shall not overlap or intersect.

2. Single sources of effluent which have more than one outfall shall be limited to a single mixing zone measured from a single point.

3. Mixing zones shall not include important fish spawning or nursery areas.

4. Mixing zones shall not block any major fish migratory route.

5. Mixing zones shall not include the hypolimnion of any body of water.

6. Mixing zones shall not include any water intake.

7. Water quality criteria must be met at every point outside the mixing zone. In addition, at no place in the mixing zone shall the 96-hr. median tolerance limit (96-hr. TLm) to aquatic life be exceeded.

F. GENERAL CRITERIA

1. All waters of Lake Erie shall meet the following conditions at all times:

   a. Free from substances that enter the waters as a result of human activity and that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl.

   b. Free from floating debris, oil, scum and other floating materials entering the waters as a result of human activity in amounts sufficient to be unsightly or deleterious.

   c. Free from substances entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance.

   d. Free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life.

e. Free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae.

2. No substances shall be introduced into these waters which would cause or contribute to the violation of any of the objectives of paragraph F-1.

3. The criteria of paragraph F-2 shall be applicable at all times and at all areas, including within mixing zones and excepted areas.

G. FECAL COLIFORM ORGANISMS (Storet No. 31616)

1. All areas of Lake Erie shall be suitable for Whole Body Contact Recreation.

2. Fecal coliform organisms (either MF or MPN) shall not exceed 200 per 100 ml based upon not less than 5 samples per month, nor shall any sample exceed 400 per 100 ml.

H. DISSOLVED OXYGEN (Storet No. 00300)

1. Dissolved oxygen in the epilimnion shall be at a minimum of 80% of saturation at all times, and at no time shall the dissolved oxygen content be below 6 mg/l.

2. Dissolved oxygen in the hypolimnion shall not be less than necessary for the support of fishlife, particularly cold water species.

I. CHLORINE (Storet No. 50060)

1. Chlorine shall be effectively neutralized before it is discharged into the receiving body of water.

2. The chlorine concentration shall not exceed 0.002 mg/l at any time and shall be determined amperometrically.

3. As an alternative to paragraph I-2, owners of waste treatment installations employing chlorination as a means of effluent disinfection are encouraged to convert to non-chlorinous microbiocides such as ozone.

J. pH (Storet No. 00400)

The pH shall be within the range of 6.7 to 8.5.

K. RADIOACTIVITY

Radioactivity should be kept at the lowest practicable levels. In any event, discharges should be controlled to the extent necessary to prevent harmful effects on health.

L. CHEMICAL CONSTITUENTS

1. Chemical constituents shall not exceed the following concentrations:

Constituent	Storet Number	Concentration (mg/l)
Ammonia Nitrogen as N (un-ionized)	00610	0.02[2]
Arsenic	01000	0.005[2]
Barium	01005	0.001[1]
Biochemical Oxygen Demand (5-day)	00310	1.0[1]
Cadmium	01025	0.01[3]
Carbon Chloroform Extract (CCE)	32005	0.05[1]
Chloride	00940	30.0[1]
Chromium	01030	0.05[2]
Copper	01040	0.01[2]
Cyanide	00720	0.005[2]
Fluoride	00950	0.2[2]
Iron (Total)	01045	0.3[3]
Lead	01049	0.05[3]
Manganese (Total)	01055	0.05[3]
Methylene Blue Active Substance (MBAS)	38260	0.05[1]
Mercury (Total)	71900	0.0005[1]
Total Inorganic Nitrogen as N	-	0.3[4]
Nickel	01065	0.05[2]
Oil (Hexane Soluble)	00550	0.5[1]
Phenols	32730	.001[3]
Phosphorus as P (Total)	70505	0.015[4]
Selenium	01145	0.01[3]
Silver	01075	0.05[3]
Sulfate	00945	40.0[1]
Total Solids (Dissolved)	00515	200.0[1]
Zinc	01090	0.05[2]

[1] Existing Water Quality

[2] NTAC Recommendations (Aquatic Life)

[3] USPHS Drinking Water Standards

[4] Lake Erie Enforcement Conference

2. In addition to the limitations of paragraph L-1,

   a. Concentrations of materials that are non-persistent (defined as materials having a half-life of less than 96 hrs.) and that have no cumulative effects shall conform to the following limitations:

      (1) Such concentrations shall not exceed 1/10 of the 96-hour TLm value.

      (2) The 24-hour average of such concentrations shall not exceed 1/20 of the 96-hour TLm.

   b. Concentrations of materials that are persistent (defined as materials having a half-life of 96 hours or more) or have cumulative effects shall conform to the following limitations:

      (1) Such concentrations shall not exceed 1/20 of the 96-hour TLm value.

      (2) The 24-hour average of such concentrations shall not exceed 1/100 of the 96-hour TLm value.

3. In addition to the limitations of paragraphs L-1 and L-2,

   When two or more toxic materials that have additive effects are present at the same time, their concentrations shall be limited by the formula:

$$\frac{Ca}{La} + \frac{Cb}{Lb} \cdots + \frac{Cn}{Ln} \leq 1$$

   where Ca, Cb, Cn are the measured concentrations of the several toxic materials in the water and La, Lb, Ln are the respective permissible concentration limits derived for the materials on an individual basis.

M. <u>TEMPERATURE</u> (Storet No. °F, 00011, °C, 00010)

1. For purpose of this section, "natural water temperature" is that temperature which would occur in a lake or stream

that did not receive heat from an artificial source. If artificial-source heat alters the natural water temperature then a natural water temperature will be established by the appropriate regulatory agency on the basis of selection from an area as nearly representative of natural conditions as possible.

2. Water temperatures shall be taken in the surface three feet (one meter) at such depth as to avoid thin layer surface warming due to extreme ambient air temperatures, but where required to determine the true distribution of heated waters and natural variations in water temperature, measurement shall be made at greater depths and at several depths as a thermal profile.

3. Heated discharge shall not alone or in combination with other substances or wastes:

   a. render the receiving waters unsafe or unsuitable for any recreational use or as a source for water supply;

   b. be injurious to wildlife, waterfowl, fish or other aquatic life or the growth and reproduction thereof; and/or

   c. stimulate the production of nuisance organisms or vegetation.

4. Heat shall not be added to Lake Erie during any month in excess of the amount that will raise the temperature of the epilimnion at the edge of the mixing zone more than 3°F (1.6°C) above the existing natural temperature nor to temperatures higher than those listed below, whichever is lower.

   a.

January	39	July	81
February	39	August	81
March	43	September	78
April	54	October	69
May	66	November	58
June	76	December	46

   b. In addition to the requirements of Item E, the mixing zone of any heated waste discharge shall not extend beyond 300 feet from a fixed point adjacent to the discharge.

5. The hypolimnetic waters of Lake Erie shall not exceed:

   a. 60°F in the Central basin, and

   b. 50°F in the Eastern basin.

6. The following applies to all waste heat discharges to Lake Erie:

   a. There shall be no proliferation of new power plants on Lake Erie.

   b. All new waste heat discharges exceeding 0.1 billion BTU/hr. which have not begun operation as of July 1, 1972, and which plan to use Lake Erie waters for cooling, excepting municipal waste and water treatment plants, must limit cooling water discharges to that amount essential for blowdown in the operation of a closed-cycle cooling facility. In all cases construction of closed-cycle systems and associated intake and discharge facilities shall be completed at the time any such discharge commences.

   c. Any heat source not in operation as of July 1, 1972 shall meet the following restrictions:

      (1) Neither the bottom, the shore, the hypolimnion, nor the thermocline shall be affected by any heated effluent.

      (2) No heated effluent shall affect spawning grounds or fish migration routes.

      (3) Discharge structures shall be so designed as to maximize short-term mixing and thus to reduce the area significantly raised in temperature.

      (4) No discharge shall exceed ambient temperatures by more than 15°F.

      (5) Heated effluents from more than one source shall not interact.

(6) All reasonable steps shall be taken to reduce the number of organisms drawn into or against the intakes.

(7) Cleaning of condensers shall be accomplished by mechanical devices. If chemicals must be used to supplement mechanical devices, the concentration at the point of discharge shall not exceed the 96-hour TLm for fresh water organisms.

d. The owner or operator of a source of heated effluent which discharges 0.5 billion BTU/hr. or more shall demonstrate to the appropriate agency not less than 2 nor more than 3 years after adoption of these standards, that discharges from that source have not caused and cannot be reasonably expected in the future to cause significant ecological damage to the Lake. If such proof is not made to the satisfaction of the appropriate agency, backfitting of alternate cooling devices shall be accomplished within a reasonable time as determined by the appropriate agency.

III. IMPLEMENTATION PLAN

As part of a complete standards package each State will submit for Federal approval a comprehensive implementation plan including interim dates for meeting the proposed Lake Erie objectives. The plan must provide for the following compliance schedule:

A. Year-round disinfection requirements to comply with applicable microbiology criteria by April 1, 1973.

B. Phosphorus removal requirements to comply with the accelerated program as envisioned by the Canadian-American Water Quality Agreement and defined by a completion date of December 31, 1973 or any earlier date when in force.

C. Completion of adequate treatment by December 31, 1975 so that no effluent, alone or in combination with other discharges, causes a violation of any applicable water quality standards. Where a discharger is presently under an enforcement compliance schedule the compliance dates will supersede the above.

D. Adequate treatment of combined sewer overflows to comply with applicable criteria by December 31, 1977.

IV. RATIONALE FOR PROPOSED LAKE ERIE CRITERIA

A. GENERAL

To meet the national goals established by Congress in the Water Quality Act of 1965, State-Federal water quality standards must be designed to enhance the quality of water(4). Standards providing for less than existing water quality are not in symphony with the letter and spirit of the 1965 Act and as such are of limited use as tools in successfully meeting the national objectives. In view of the mounting challenges of population and industrial growth, urbanization and technological change, meaningful standards must provide for:

1. potential and future water uses as well as present uses;

2. the enhancement of all waters presently affected by pollution to that quality capable of sustaining recreational uses and beneficial aquatic biota; and

3. the maintenance and protection of waters presently of a high quality.

Existing Lake Erie State-Federal water quality standards do not assure the goal of water quality enhancement. Unfortunately, the present criteria are not sufficient to protect the current impaired quality of the Lake's waters. Although an antidegradation statement is included in the established standards of each Lake Erie State, none of the standards reflect this essential concept in the specific criteria. Obviously the established State-Federal water quality standards for Lake Erie need to be improved.

Lake Erie standards must be designed to protect the Lake's unique characteristics. These characteristics include greater clarity and depth, and longer retention periods as compared to free flowing streams. In addition, the geological processes of aging, with the ultimate termination of a lake as a healthy, ecologically balanced water body, are distinct in many ways from those which characterize a flowing stream. Importantly, the lesser capacity of Lake Erie for self-cleansing and renewal, coupled with its present eutrophic state, places upon man a greater burden and responsibility to provide the protection and enhancement measures which the Lake, as a result of massive cultural impact, cannot accomplish on its own.

Accordingly, stringent standards are necessary for the protection and enhancement of Lake Erie water quality and for the very preservation of the Lake as a viable water body.

Water quality criteria establish goals. Developed after technical studies, discussions and open hearings, and consistent with congressional directives, water quality criteria are the conclusions of an informed public as to the desired water uses and water quality. Criteria provide a major management device whereby persons whose activities affect water quality, and water quality administrators, may determine the specific treatment or control measures required to meet the basic objectives. Consequently, criteria must be meaningful, realistic and clear. Most essentially, their substantive goals must fully assure satisfactory water quality.

The recommendations of this report are based on the belief that water quality standards for Lake Erie must establish acceptable, endorsed goals, which when met, will protect and enhance the water quality of Lake Erie for the preservation and subsequent well-being of this important natural resource.

B. PRESENT LAKE ERIE WATER QUALITY

The Western and Central basins of Lake Erie are in an advanced trophic state. In fact, the Central basin hypolimnion has reached the fourth phase of stagnation as described by Hutchinson (6). In the most serious phase IV, oxygen is much reduced, the oxidation-reduction potential is very low, much ionic soluble phosphorus is present, and excess hydrogen sulfide exists removing solubilized sediment ferrous iron by precipitation. All of the above criteria are analytically identifiable in the Central basin hypolimnion by August (1, 11). The significance of the above lies in the fact that the removal of ferrous iron as the sulfide now precludes the desirable autumnal resedimentation of phosphorus as the ferric salt under renewed oxidative conditions. Apparently as long as summer anoxic conditions exist in the Lake Erie Central basin hypolimnion, sediment phosphorus regeneration with subsequent predictive results will occur. Latest studies show even the Eastern basin to be well on the way toward eutrophy. A Canadian cruise determined that conditions close to anoxia were prevalent in many parts of the Eastern basin hypolimnion in August 1970 (8).

Compared to the other Great Lakes, most of Lake Erie has always been in a more advanced state of aging because of its physical characteristics of relatively small volume, warmth, and higher sediment input. However, since the turn of the century when man first had a significant effect on it, Lake Erie has aged an estimated 15,000 years (7). The premature aging of Lake Erie has been verified by measurements of many parameters. Planktonic algae are decreasing in variety but increasing tremendously in numbers. Algae are becoming dominated by the blue-green or pollution tolerant types. Attached algae are also luxuriant. The

common attached alga, Cladophora, grows in ever-widening mats in shallow water all along the shores of the Lake where suitable habitat exists. Dissolved solids are accreting in the Lake at a very rapid rate, having increased 20 percent in the past 40 years. Desirable fish, the prime game and commercial species, such as cisco, blue pike, and walleye, have disappeared or declined drastically while the less desirable fish such as smelt, sheepshead, and carp, have increased sharply.

Bottom organisms are changing or have changed from a great diversity with relatively few numbers to a narrow hardy variety with very large populations. Tremendous numbers of sludgeworms, up to 30,000 or more per square yard, now inhabit bottom areas which not long ago were dominated by mayflies and other pollution-sensitive invertebrates in numbers two orders of magnitude less. In the Western basin the area dominated by sludgeworms has increased more than ten times since 1930 (7).

Studies made 45 years ago recorded no bottom areas seriously depleted of oxygen but recent investigations (1,2) reveal that severe oxygen deficiencies now clearly occur throughout most of the Central basin and a great deal of the Eastern basin. Since the Western basin is not deep enough to sustain a permanent summer temperature-density stratification, this basin suffers only short-time, acute, bottom water oxygen deficiencies. However, in the Western Basin nearshore chronic oxygen depletion, defined by oxygen concentration as low as 45% saturation in the Port Clinton area, is commonplace.

Many Lake Erie shoreline areas are fouled by bacterial contamination indicating unfitness for human recreational uses. Combined, these contaminated areas total nearly one-third of the entire shore length on the United States side. The most extreme conditions prevail near Detroit and Cleveland, where the bacterial concentrations vastly exceed the levels which indicate safe swimming conditions (7).

C. RATIONALE FOR TEMPERATURE CRITERIA RECOMMENDATIONS

The recommended thermal criteria specify monthly maximum temperatures and temperature rise limitations. The criteria represent the 95th percentile of most all the United States Lake Erie municipal intake temperature data (Table I) combined with 10 years of U.S. Gypsum-Sandusky Bay data (Table II) and the many years of available Put-in-Bay data (Table III) plus 3° and reflect the requirements of a desirable aquatic biota for the Lake. The temperature data used to develop the proposed criteria were obtained from Lake Erie sampling locations as shown on Figure I.

To fully protect aquatic life, permissible maximum temperatures must be related to times of the year. Summer temperatures adequate for a healthy, mature fish population may be excessive and injurious during other periods, such as spring spawning. While it is important to prevent excessive temperature rises, the temperature rise limitation alone does not

assure a sufficient monthly maximum temperature limitation, since an unusual warming spell during a normally cooler month may raise natural temperatures outside the limits tolerable to aquatic life during such times.

Based upon natural conditions, it is reasonable that Lake Erie temperatures be maintained to protect a fishery of walleye, yellow perch, smallmouth bass, white bass, channel catfish, drum and carp. The recommended monthly temperatures will protect these fish species.

Cool temperatures particularly benefit coho salmon and lake trout. Coho have recently been established in Lake Michigan and as biological predators have depleted the excessive, troublesome alewife in that lake to manageable populations. Certainly coho would provide the same service to Lake Erie should the need arise. In addition, coho are fantastic game fish. While there are optimistic signs that the coho salmon stocking program may enjoy long term success, Lake Erie presents a rather precarious environment for this cold water species. In addition, the re-establishment of lake trout, a species native to the Eastern basin of Lake Erie, may be possible by the maintenance of cooler temperatures.

Adherence to the recommended temperature criteria, while not the sole factor for the success of these two efforts, will help preserve and expand the desirable coho population and greatly assist the efforts to expand trout in the lake.

The existing relatively low Lake Erie temperatures in both shore and open waters (insofar as the data permit comparison) readily demonstrate that these fishery goals are wholly realistic.

Unfortunately, the present ecological state of Lake Erie is overly productive with respect to periphyton and planktonic organisms of both plant and animal origin. Inherent in this condition is the establishment in Lake Erie of the troublesome taste and odor producers, the blue-green algae. Hartley and Potos (5) state that blue-green algae prefer aquatic temperatures in excess of 20°C. These authors graphically portray explosive coccoid, and filamentous blue-green algae blooms when temperatures in the Western basin of Lake Erie exceed 24°C (77°F). To keep this condition of biologic overproductivity and aquatic species shift from worsening, every effort should be made to prevent Lake Erie temperatures from increasing.

The recommendations presented herein are intended primarily to maintain existing temperatures by minimizing future heat inputs resulting from the activities of man. However, some reduction in current thermal input may also result from implementing the mixing zone standard as proposed. If existing temperatures are to be maintained, then temperature criteria on Lake Erie will have to be varied depending upon the particular areas, and must be selected using existing data

as the basis. It is necessary that there be separate criteria for the hypolimnion, both in the Central and Eastern basins, as compared to the epilimnion.

In certain areas, including Sandusky Bay and the shallow waters of the island area, natural temperatures may at times be slightly higher than the recommended criteria. Therefore, limited exceptions may properly be established for these areas. However, it is imperative that any exception include a clear requirement that there shall be no additional future thermal input from any source to these nearshore areas.

The available data demonstrate a notable lack of daily and monthly temperature variability from year to year. For example, in the more than 50 years of record at Put-in-Bay, over half the years had no temperatures exceeding 80°F., and only a few years had temperatures exceeding 84°F. The similar lack of variability in Sandusky Bay is significant, particularly as the 99th percentile temperatures in Sandusky Bay exceed only slightly the 99th percentile temperatures for Put-in-Bay (Table IV).

Furthermore, examination of 21 municipal intakes on the south shore of Lake Erie varying in depth from 4 to 38 feet, reveals temperature differences of only a few degrees during that period where data are available. Many of the shallow water intake temperatures are representative of the surface and most likely reflect extreme highs, except perhaps for those temperatures that occur during short periods on hot, sunny days and that affect only the top few inches of water. Others are deeper water temperatures reflecting the other end of the natural aquatic temperature spectrum. In addition, the municipal intake temperature differences reflect the Eastern basin spring temperatures which are relatively low - unlike Western and Central basin spring temperatures - due to massive and prolonged Eastern basin ice flow detention, the result of the Niagara River bottleneck. Based upon the above, the small, maximum lakewide municipal intake variations assume added significance and speak of high temperature homogeneity throughout the Lake, exclusive of the summer hypolimnion.

D. RATIONALE FOR NON-THERMAL CRITERIA RECOMMENDATIONS

The recommendations for the non-thermal parameters are based on the combined goals of maintaining and enhancing water quality and of meeting the nation's obligations under the recent Canadian-American Great Lakes Water Quality Agreement (3). Criteria recommendations for these parameters derive from five sources: existing water quality data (Table V), the stated objectives of the international agreement, and recommendations of the NTAC (12), the Lake Erie Enforcement Conference (13) and the USPHS Drinking Water Standards (14).

Portions of the recommended criteria prescribe water quality conditions better than those presently existing in many nearshore locations, especially in areas of high population density. In these

areas, the criteria provide for and require water quality enhancement. The criteria are objectives which will be reached upon successful implementation of necessary pollution control programs.

In addition to the above general approach, specific rationales in support of various recommendations are as follows:

1. Analytical Methodology

   Chemical analyses are to be made pursuant to the latest edition of the EPA Methods Text. The 1971 manual was compiled by using as basic references: Standard Methods for the Examination of Water and Wastewater, 13th Ed. (1971); ASTM Standards, Part 23, Water; Atmospheric Analysis (1970) and current water pollution control literature. The EPA text is an extension of the above references and includes the most recent methods reflecting maximum analytical precision and accuracy.

2. Mixing Zones

   The objectives of the International Joint Commission (IJC) recognize the concept of mixing zones. Basic mixing zone principles are included in the NTAC report. The 300 foot thermal mixing zone limitation is consistent with the New York State standards for lakes (including Lake Ontario) and reservoirs.

3. General Criteria

   The general criteria describe conditions of water quality applicable to all locations at all times in Lake Erie. These criteria, based upon the IJC objectives, assure that unreasonable, extreme pollution conditions will not occur at any time and that minimum unquantifiable aesthetic levels will be constantly maintained.

4. Fecal Coliform Organisms

   The recommended fecal coliform criteria are based upon the NTAC recommendation for primary contact recreation. Since fecal coliform are only indicator organisms for the prediction of unsafe

conditions rather than a direct measure of fitness, no increase in these levels as a result of human activities should be tolerated.

5. Dissolved Oxygen

The recommended dissolved oxygen criteria reflect existing conditions in Lake Erie. The 6.0 mg/l minimum and the narrative provision applicable to hypolimnetic waters are IJC objectives. Adherence to these recommended criteria will contribute towards the maintenance of a favorable habitat for indigenous aquatic biota.

6. Chlorine

There is growing evidence of the hazards which chlorine discharges pose for the indigenous aquatic life resource. The recommended level was developed at the EPA National Water Quality Laboratory in Duluth, Minnesota, and provides for the successful completion of life cycles, including reproduction, of the fishes to be protected and the relative persistence of total residual chlorine in the environment. The amperometric method should be used since the colorimetric procedures are subject to gross errors from oxidative interferences. The recommended criteria state a preference for non-chlorinous microbiocides because detrimental accretions of dissolved solids are inherent in the chlorine neutralization process.

7. Hydrogen Ion Concentration

The criteria for pH is compatible with the IJC objectives as defined in the Canadian-American Great Lakes Water Quality Agreement.

8. Radioactivity

The recommended levels of radioactive constituents are based upon IJC objectives as defined in the Great Lakes Water Quality Agreement.

9. Chemical Constituents

All recommended levels for chemical constituents are based upon existing water quality, the National Technical Advisory Committee recommendations to protect aquatic life, the United States Public Health Service Drinking Water Standards and the Lake Erie Enforcement Conference requirements.

E. LOCALIZED AREAS

The Great Lakes Water Quality Agreement includes the following provision:

> *"There will be other restricted, localized areas, such as harbors, where existing conditions such as land drainage and land use will prevent the objectives from being met at least over the short term; such areas, however, should be identified specifically and as early as possible by the responsible regulatory agencies and should be kept to a minimum."*

Water quality standards adopted by any State contiguous to Lake Erie should specifically identify and delineate each area, if any, within the jurisdiction of the adopting State where the established standards will not immediately apply. Any such area should be kept to a minimum and the State should develop a remedial plan and schedule for the area. Such identification, delineation, plan and schedule should be developed cooperatively with the EPA.

V. CONCLUSION

It is the firm belief of the Environmental Protection Agency that in order to adequately protect Lake Erie from further degradation, to enhance Lake Erie water quality and to fulfill the international obligations of the United States, Lake Erie water quality criteria that are consistent from State to State and that reflect existing or desired water quality must be promptly incorporated into enforceable State-Federal water quality standards, standards that will be attained through the implementation of appropriate protective, discharge criteria. To that end, this report is dedicated.

VI. REFERENCES

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(7) Lake Erie Report, A Plan for Pollution Control, USDI, FWPCA, 1968.

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(10) Mount, D.I., Recommended Temperature Criteria for Lake Erie, Correspondence to USEPA Ohio District Office Director, 1969.

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(12) Report of the Committee on Water Quality Criteria, USDI, FWPCA, 1968.

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(14) United States Public Health Service, Drinking Water Standards, 1962.

FIGURE 1

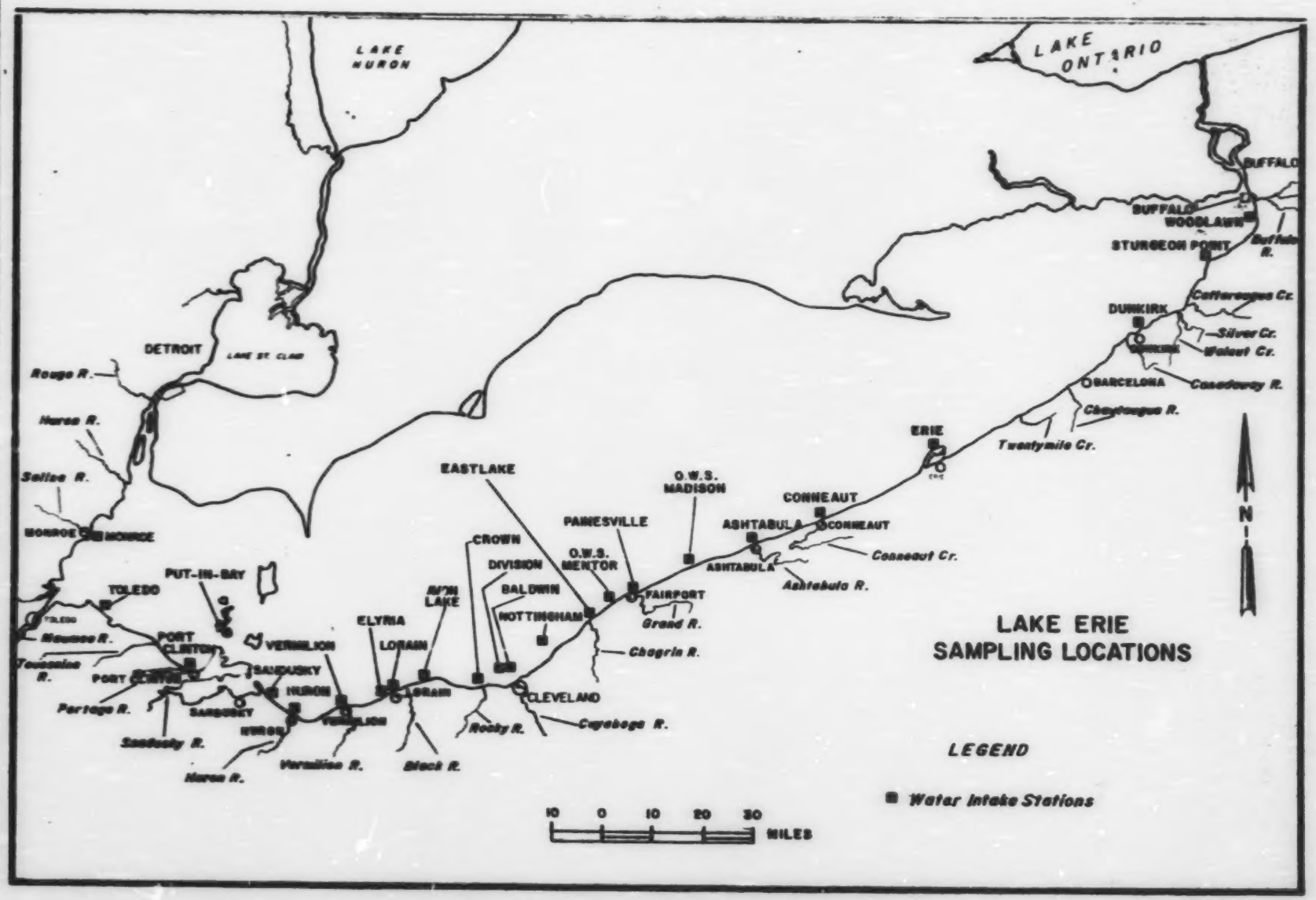
LAKE HURON
LAKE ONTARIO
BUFFALO
BUFFALO WOODLAWN
STURGEON POINT
Buffalo R.
DUNKIRK
Cattaraugus Cr.
Silver Cr.
Walnut Cr.
BARCELONA
Canadaway R.
Chautauqua R.
Twentymile Cr.
ERIE
DETROIT
LAKE ST. CLAIR
Rouge R.
Huron R.
Raisin R.
MONROE
EASTLAKE
O.W.S. MADISON
CONNEAUT
PAINESVILLE
ASHTABULA
CONNEAUT
Conneaut Cr.
ASHTABULA
Ashtabula R.
CROWN
DIVISION
O.W.S. MENTOR
BALDWIN
FAIRPORT
Grand R.
NOTTINGHAM
Chagrin R.
PUT-IN-BAY
TOLEDO
Maumee R.
PORT CLINTON
Portage R.
Sandusky R.
VERMILION
SANDUSKY
HURON
ELYRIA
LORAIN
BERIN LAKE
CLEVELAND
Rocky R.
Cuyahoga R.
Vermilion R.
Black R.
Huron R.
N
LAKE ERIE
SAMPLING LOCATIONS
LEGEND
Water Intake Stations
10 0 10 20 30
MILES

FIGURE II

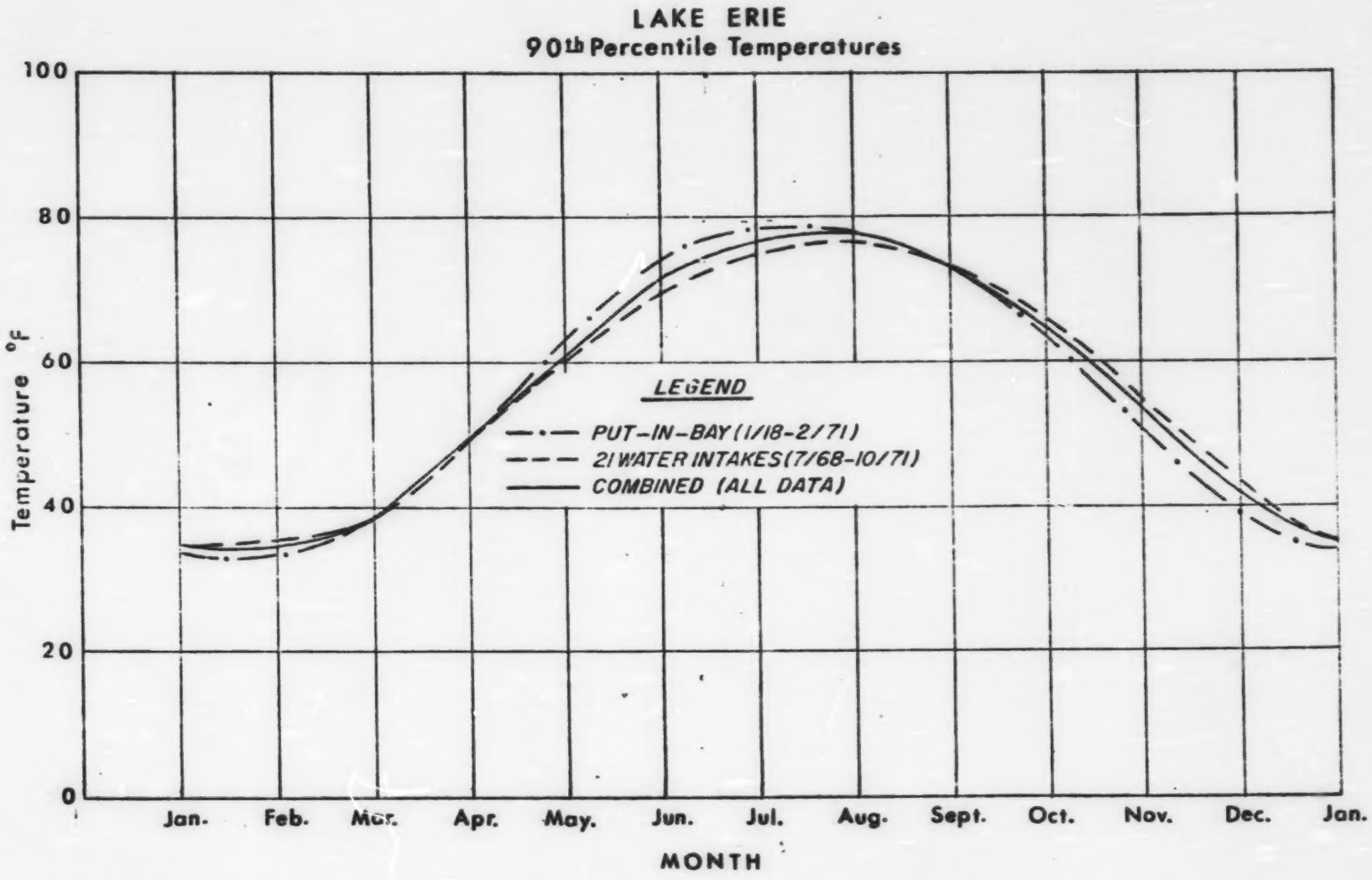
LAKE ERIE
90th Percentile Temperatures
100
80
60
40
20
0
Temperature °F
LEGEND
PUT-IN-BAY (1/18-2/71)
21 WATER INTAKES (7/68-10/71)
COMBINED (ALL DATA)
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
MONTH

FIGURE III

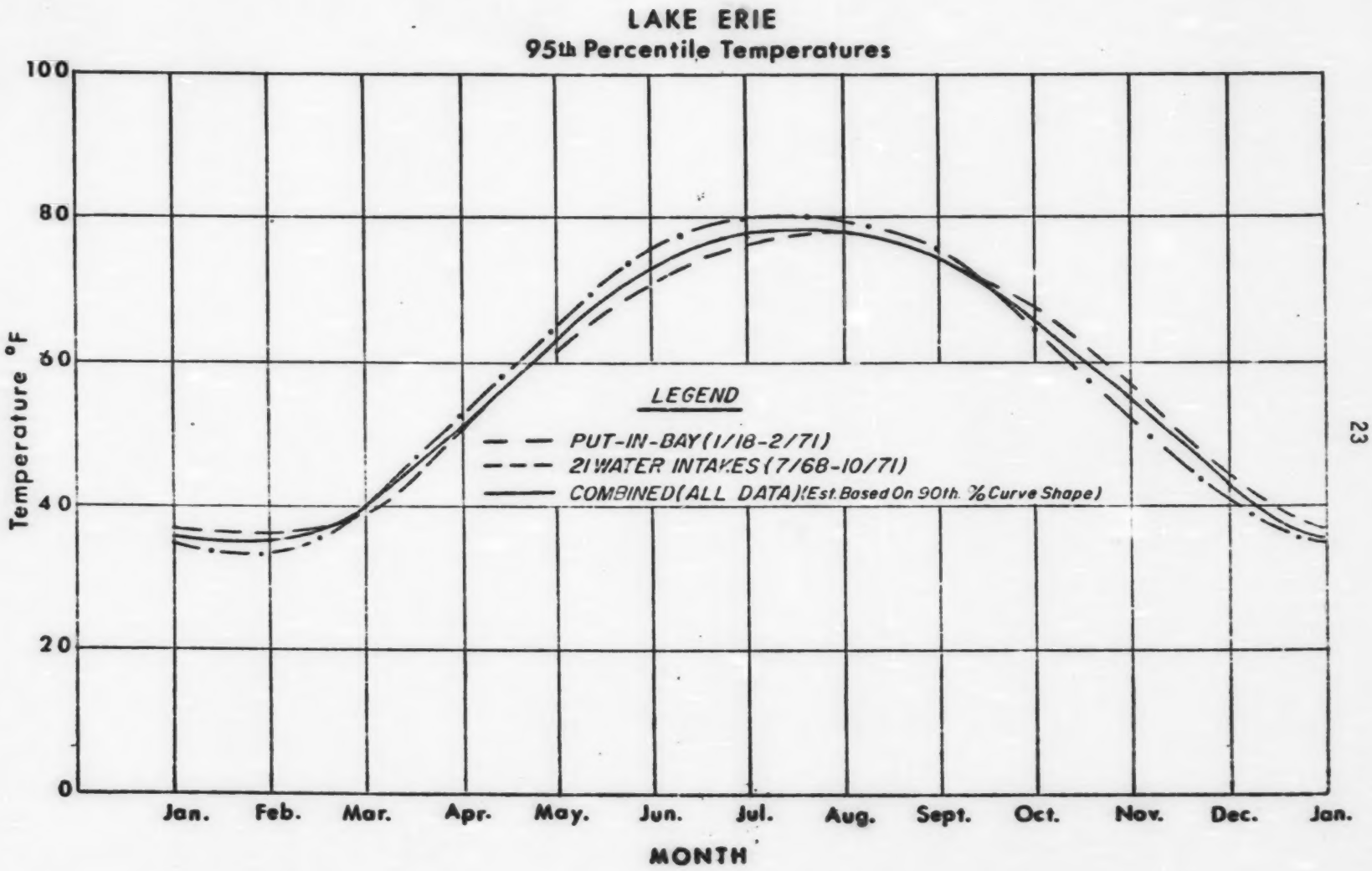
LAKE ERIE
95th Percentile Temperatures
100
80
60
40
20
0
Temperature °F
LEGEND
PUT-IN-BAY (1/18-2/71)
21 WATER INTAKES (7/68-10/71)
COMBINED (ALL DATA) (Est. Based On 90th % Curve Shape)
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
MONTH

TABLE I

LAKE ERIE TEMPERATURE DATA (°F)
COMBINED PUT-IN-BAY & WATER INTAKES

Month	Min.	1st%	90th%	95th%	99th%	Max.	No. Readings
Jan	-	-	35	36	-	-	2877
Feb	-	-	35	35	-	-	2624
Mar	-	-	38	40	-	-	2935
Apr	-	-	50	51	-	-	2911
May	-	-	61	63	-	-	2830
Jun	-	-	72	73	-	-	2676
Jul	-	-	77	78	-	-	3085
Aug	-	-	78	78	-	-	3175
Sept	-	-	74	75	-	-	3107
Oct	-	-	65	66	-	-	3124
Nov	-	-	54	55	-	-	2694
Dec	-	-	42	43	-	-	2938

TABLE II

LAKE ERIE TEMPERATURE DATA (°F)
SANDUSKY BAY
(4:00 PM @ U.S. GYPSUM)
JULY 1961-OCTOBER 1969

Month	Min.	1st%	90th%	95th%	99th%	Max.	No. Readings
Jan	32	-	35	35	40	41	244
Feb	32	-	35	36	36	37	220
Mar	32	-	45	49	53	56	244
Apr	35	-	57	59	65	68	237
May	48	-	70	73	75	76	246
Jun	60	-	78	79	81	82	240
Jul	61	-	80	81	82	84	269
Aug	63	-	78	78	83	84	278
Sept	49	-	75	77	80	81	268
Oct	33	-	62	63	66	67	270
Nov	31	-	50	52	55	58	240
Dec	32	-	36	39	40	44	234

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TABLE III

LAKE ERIE TEMPERATURE DATA (°F)
PUT-IN-BAY
JANUARY 1, 1918-FEBRUARY 28, 1971

Month	Min.	1st%	90th%	95th%	99th%	Max.	No. Readings
Jan	32.0	32.0	34.0	35.0	38.0	40.0	1491
Feb	31.0	33.0	34.0	34.0	36.0	38.0	1352
Mar	32.0	33.0	38.0	40.0	43.0	46.0	1504
Apr	33.0	34.0	50.0	52.0	56.0	61.0	1509
May	44.0	46.0	63.0	65.0	68.0	75.0	1472
Jun	54.0	57.0	74.0	76.0	80.0	82.0	1285
Jul	67.0	68.0	79.0	80.0	84.0	90.0	1331
Aug	68.0	69.0	78.0	79.0	82.0	85.0	1345
Sept	52.0	58.0	74.0	76.0	79.0	82.0	1273
Oct	35.0	46.0	64.0	65.0	68.0	70.0	1354
Nov	33.0	35.0	51.0	53.0	55.0	57.0	1424
Dec	32.0	32.0	39.0	41.0	43.0	49.0	1561

TABLE IV

99TH PERCENTILE TEMPERATURES IN °F
RECORDED FOR VARIOUS LOCATIONS
IN LAKE ERIE

Month	Put-in-Bay 1959-1969	Sandusky Bay 1961-1969	21 Municipal Intakes 1968-1971
Jan	38	40	43
Feb	36	36	38
Mar	43	53	41
Apr	56	65	54
May	68	75	65
Jun	80	81	73
Jul	84	82	77
Aug	82	83	79
Sept	79	80	77
Oct	68	66	69
Nov	55	55	59
Dec	43	40	48

TABLE V

COMPARISON OF LAKE ERIE WATER QUALITY STANDARDS
SPECIFIC CRITERIA (MOST RESTRICTIVE IN OPEN WATERS)

Parameter	Michigan	Ohio	Penn.	New York	Ontario	NEAC Criteria	IJC Objective	Existing Water Quality
Dissolved Oxygen(ppm) Daily average Minimum (Aquatic Life Most Restrictive)	5 4	5 4	6 5	5	6 5	6 5	6	% Saturation - Summer Basin / Surface / Hypolimnion Western / 90-100 / -- Central / 90-100 / 40-60 Eastern / 90-100 / 50-70 any reach 0
pH (Range) (Aquatic Life)	6.5-8.8	6.0-8.5	7.0-9.0	6.5-8.5	6.5-8.5	6.0-9.0	6.7-8.5	7.16-9.54 Mean 8.35 (1970 - Cruise)
Radioactivity (pc/l) Gross Beta Radium-226 (alpha) Strontium-90	1000 about about	1000 3 1	NSC	NSC	1000 3 1	1000 3 1	NSC	Two year sampling 1st year Mean alpha activity 2.2 Mean beta activity 1.4 2nd year Mean alpha activity 5.3 Mean beta activity 7.4
Temperature(°F) Rise above natural temperature Maximum temperature Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec (Aquatic Life Most Restrictive)	3 45 45 45 60 70 75 80 85 80 70 60 50	3 50 50 60 70 80 90 90 90 90 78 70 57	5 50 	3 NSC 	NSC NSC 	3 	NSC NSC 	95th Percentile Temperatures Using data from Put-in-Bay & 21 Water Intakes 36 35 40 51 63 73 78 78 75 66 55 43

NSC - No Specific Criteria

TABLE V
(Comparison Continued)

Parameter	Michigan	Ohio	Penn.	New York	Ontario	IJC	NYAC	Existing Water Quality
Total Coliform Organisms/100 ml as type of average of number of consecutive samples	≤1000 arithmetic 10	NSC	≤1000 arithmetic --	≤2400 arithmetic ≤4/30 days	≤1000 geometric ≤10/month	≤1000 geometric ≤5/≤30 days	NSC	Maximum 410,000 Mean 1,741 Minimum 0 (1968-1971 Lake Erie Intake Water Quality Summary)
Organisms/100 ml in number of consecutive samples	≤5000 20%		≤1000 2	≤2400 20%				
Organisms/100 ml maximum			≤2400					
(Total Body Contact)								
Fecal Coliform Organisms/100 ml as type of average of number of consecutive samples	≤100 arithmetic 10	≤200 geometric ≤5/month	NSC	NSC	≤100 geometric ≤10/month	≤200 geometric ≤5/≤30 days	≤200 geometric ≤5/30 days	Maximum 7,500 Mean 130 Minimum 1 (1968-1971 Lake Erie Intake Water Quality Summary)
Organisms/100 ml in number of consecutive samples		≤400 10%					≤400 10%	
(Total Body Contact)								

NYAC - No Specific Criteria

TABLE V
(Comparison Continued)

PARAMETER	MICH.	OHIO	PA.	N.Y.	ONTARIO	IJC	EXISTING WATER QUALITY 1970 Great Lakes			1970 Canadian Cruise		
							Max.	Mean	Min.	Max.	Mean	Min.
AMMONIA NITROGEN	-	-	-	$ 2.0	$ 0.5	-	1.50	0.18	< 0.01	0.875	.034	.001
ARSENIC	-	$ 0.05	-	-	$ 0.01	-	< 0.01	-	-	-	-	-
BARIUM	-	$ 1.0	-	-	$ 1.0	-	0.1	-	-	-	-	-
BOD	-	-	-	-	-	-	-	-	-	4.1	1.1	0.0
BORON	-	-	-	-	$ 1.0	-	-	-	-	-	-	-
CADMIUM	-	$ 0.01	-	$ 0.3	$ 0.01	-	0.02	-	< 0.01	0.003	.000	.000
CCE	-	-	-	-	$ 0.15	-	-	-	-	-	-	-
CHLORIDE	$ 50*	-	-	-	$250	-	540	34	2	73.8	23.2	8.2
CHROMIUM	$ 0.05	$ 0.05	-	-	$ 0.05	-	0.10	-	< 0.01	.003	.000	.000
COPPER	-	-	-	$ 0.2	$ 1.0	-	2.47	0.06	< 0.01	.022	.000	.000
CYANIDE	$ 0.2	$ 0.025	-	$ 0.1	$ 0.20	-	< 0.005	-	-	-	-	-
FLUORIDE	-	$ 1.0	-	-	$ 1.3	-	0.96	0.13	< 0.05	-	-	-
IRON	-	-	$ 0.3	-	$ 0.3	$ 0.3	6.800	0.279	< 0.004	-	-	-
LEAD	-	$ 0.05	-	-	$ 0.05	-	0.56	-	< 0.01	.015	.001	.000
MANGANESE	-	-	-	-	$ 0.05	-	3.250	0.051	< 0.005	.228	.003	.000
H2S	-	-	$ 0.5	-	$ 0.5	-	-	-	-	-	-	-
MERCURY	-	-	-	-	-	-	0.0005	0.0001	0.0001	.011	.000	.000
NITRATE & NITRITE	-	-	-	-	$ 10	-	0.48	0.15	< 0.01	1.080	0.113	.000
NICKEL	-	-	-	-	-	-	0.22	0.02	< 0.01	.012	.002	.000
OIL	-	-	-	-	A	-	-	-	-	-	-	-
PHENOLS	$ 0.005	-	-	$ 0.005	A	-	-	-	-	-	-	-
PHOSPHORUS	-	-	-	-	-	-	1.87	0.07	< 0.01	0.149	0.024	0.004
SELENIUM	-	$ 0.01	-	-	$ 0.01	-	0.003	-	-	-	-	-
SILVER	-	$ 0.05	-	-	$ 0.05	-	0.020	-	< 0.01	-	-	-
SULFATE	-	-	-	-	$250	-	141	24	< 1	31.2	25.6	15.4
DISSOLVED SOLIDS	$200	$750	$750	-	$500	$200	426	194	7	297	197	138
ZINC	-	-	-	$ 0.3	$ 5	-	0.96	0.08	< 0.01	.090	0.000	.001

All units are ug/l
A - virtually absent
*Monthly average

TABLE VI

LAKE ERIE TEMPERATURE DATA (°F)
MONROE, MICHIGAN
MUNICIPAL WATER INTAKE
JANUARY 1960-MARCH 1970

Month	Min.	1st%	90th%	95th%	99th%	Max.	No. Readings
Jan	34	-	36	37	38	41	341
Feb	34	-	36	36	37	45	282
Mar	34	-	40	41	43	45	341
Apr	36	-	51	52	54	57	300
May	46	-	62	62	65	69	310
Jun	57	-	70	70	72	74	300
Jul	66	-	75	76	78	79	319
Aug	59	-	74	76	77	78	309
Sept	60	-	74	74	75	75	300
Oct	50	-	63	64	66	67	310
Nov	39	-	53	54	56	59	300
Dec	34	-	43	43	45	48	310

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TABLE VII

LAKE ERIE TEMPERATURE DATA (°F)
21 MUNICIPAL WATER INTAKES
JULY 1968 - OCTOBER 1971

Month	Min.	1st%	90th%	95th%	99th%	Max.	No. Readings
Jan	32.0	32.0	35.1	37.0	42.8	48.2	1386
Feb	32.0	32.0	36.0	36.4	38.1	42.8	1272
Mar	32.0	32.8	37.8	39.2	41.0	42.8	1431
Apr	33.0	33.8	50.0	51.1	53.6	57.2	1402
May	43.4	46.0	60.4	60.8	64.9	68.0	1358
Jun	45.3	50.0	69.8	70.7	73.4	75.2	1391
Jul	52.0	55.9	75.2	75.9	77.2	78.8	1754
Aug	52.7	57.2	77.0	78.1	79.0	81.9	1830
Sept	53.2	62.6	73.9	75.2	77.0	77.9	1834
Oct	46.4	50.0	66.2	67.8	69.1	73.4	1770
Nov	33.8	35.6	55.2	56.8	59.0	60.8	1270
Dec	32.0	32.0	44.1	44.6	48.2	52.5	1377